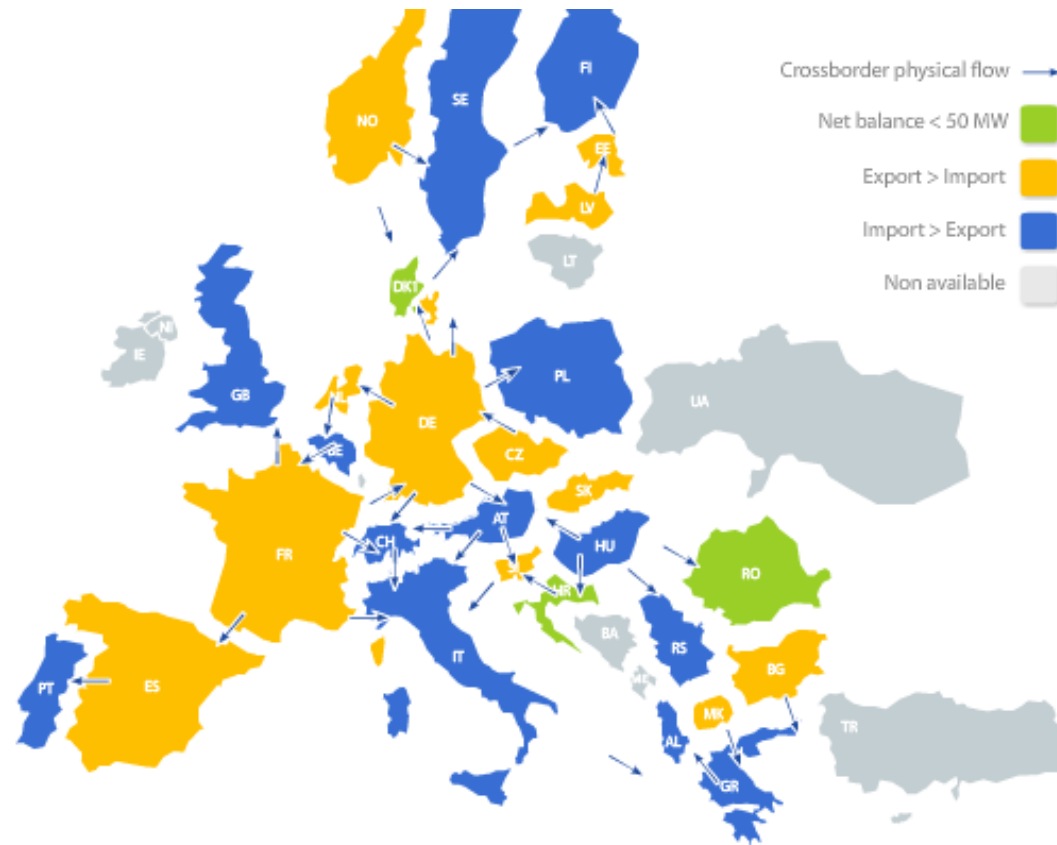

A Simulation of the European Electricity Market based on the Full Network Model

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The European electricity market today



- Capacity allocation *between* national markets (explicit/implicit auctions)
- However, network is meshed, constraints usually not aligned with political borders
- Consequence: Incoherence between institutions & technology

Source: etsovista.org

The European electricity grid

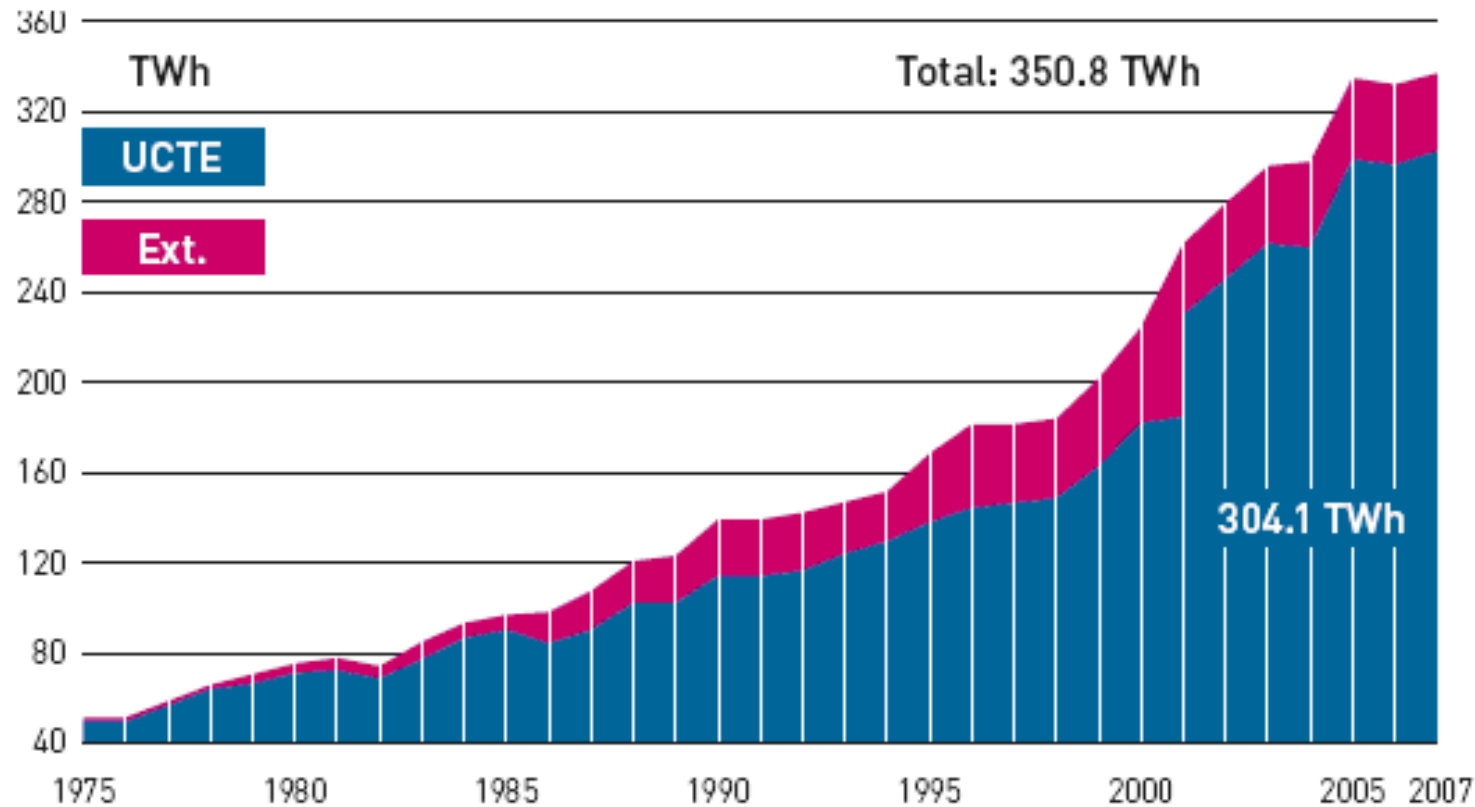


Source: Platts (2008)

Incoherence: So what?

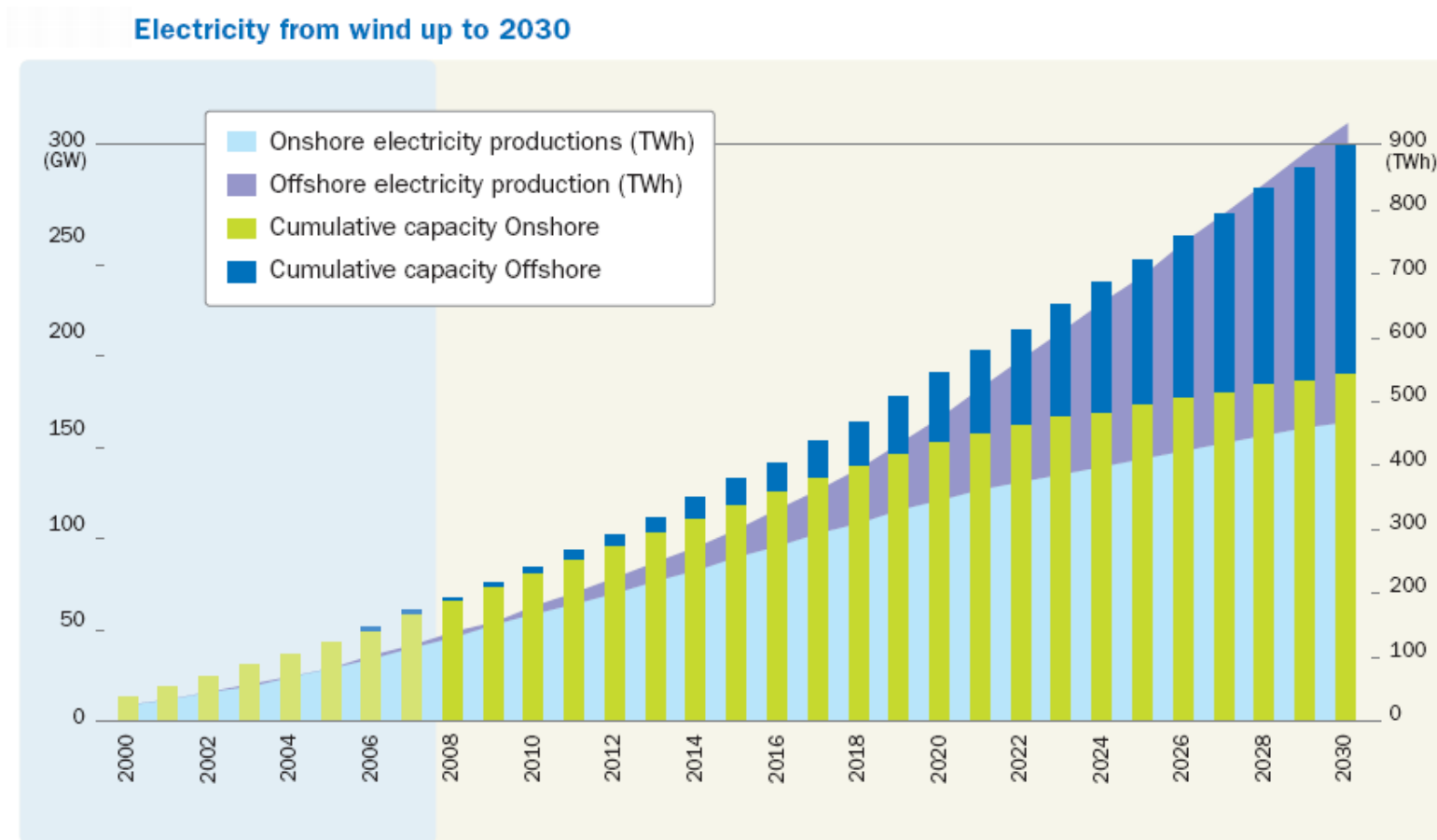
- Constraints within national zones not resolved
 - Creation of new zones is often arbitrary
- Fragmentation of European market
 - Inefficient dispatch of power plants
 - Separation of energy market and ancillary services
 - Lack of accurate price signals
- Unexpected generation & flow patterns
 - Frequent redispatch measures required
 - 2008/2009: Remarkable impact of *economic crisis*

Major challenge (1): International trade



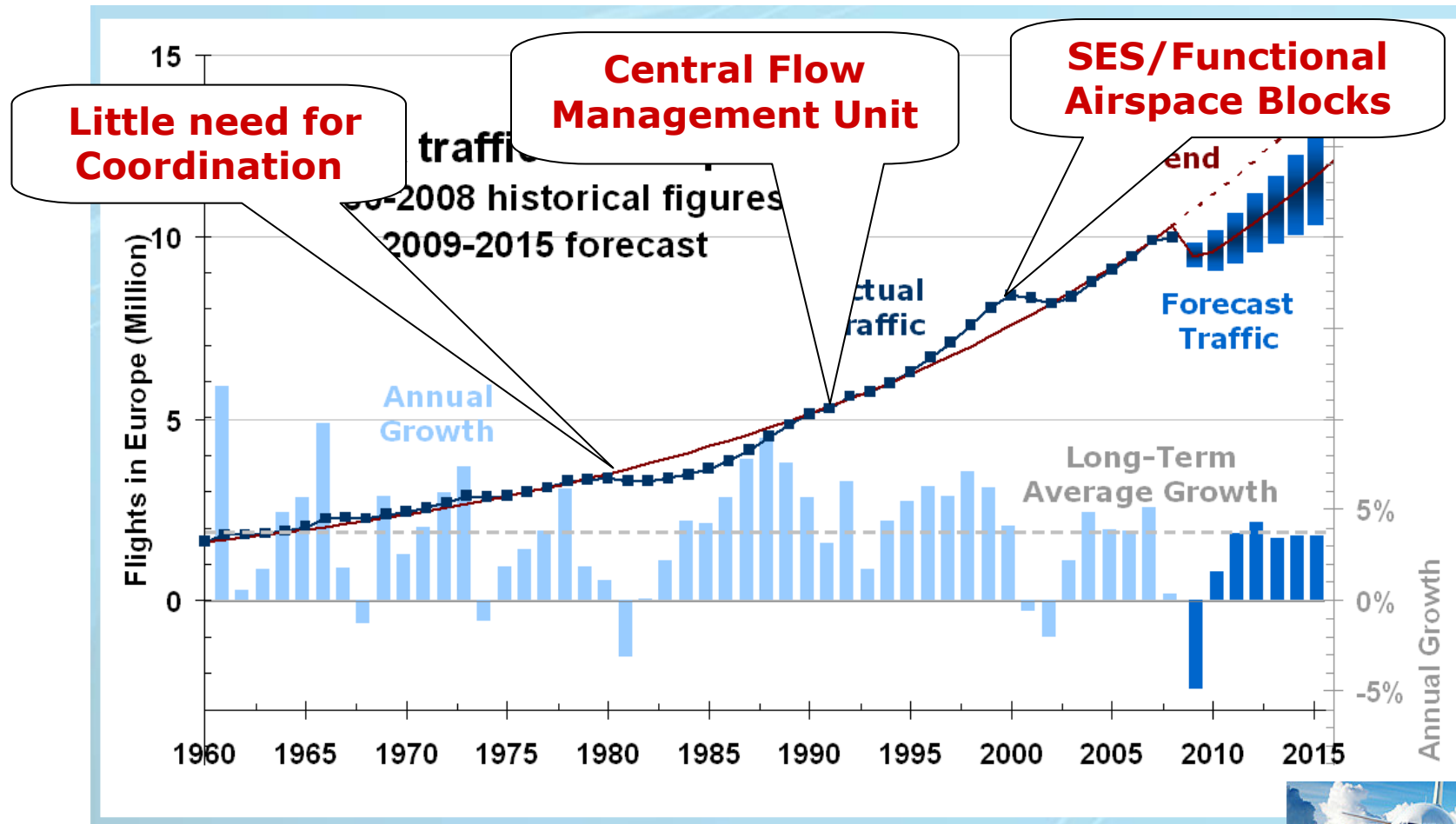
Source: UCTE (2008)

Major challenge (2): Renewables



Source: EWEA (2009)

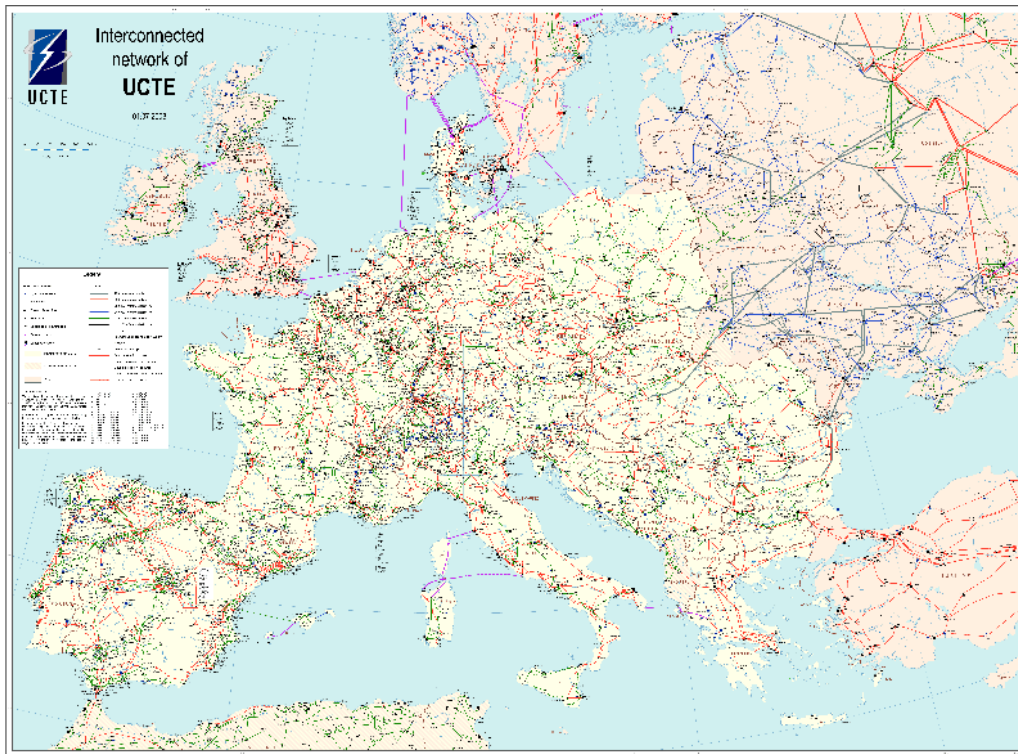
Comparison: Air Traffic Control



Source: Eurocontrol (2008)

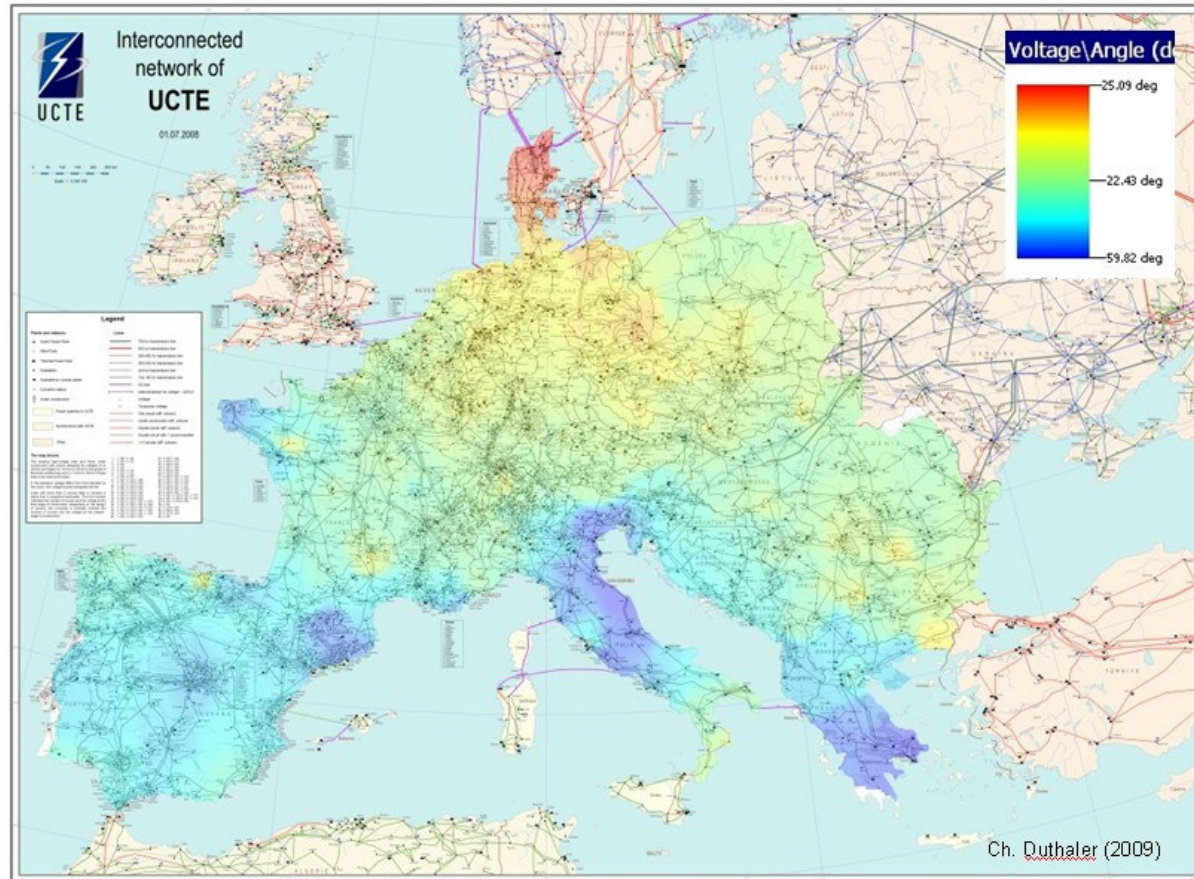


Full Network Model



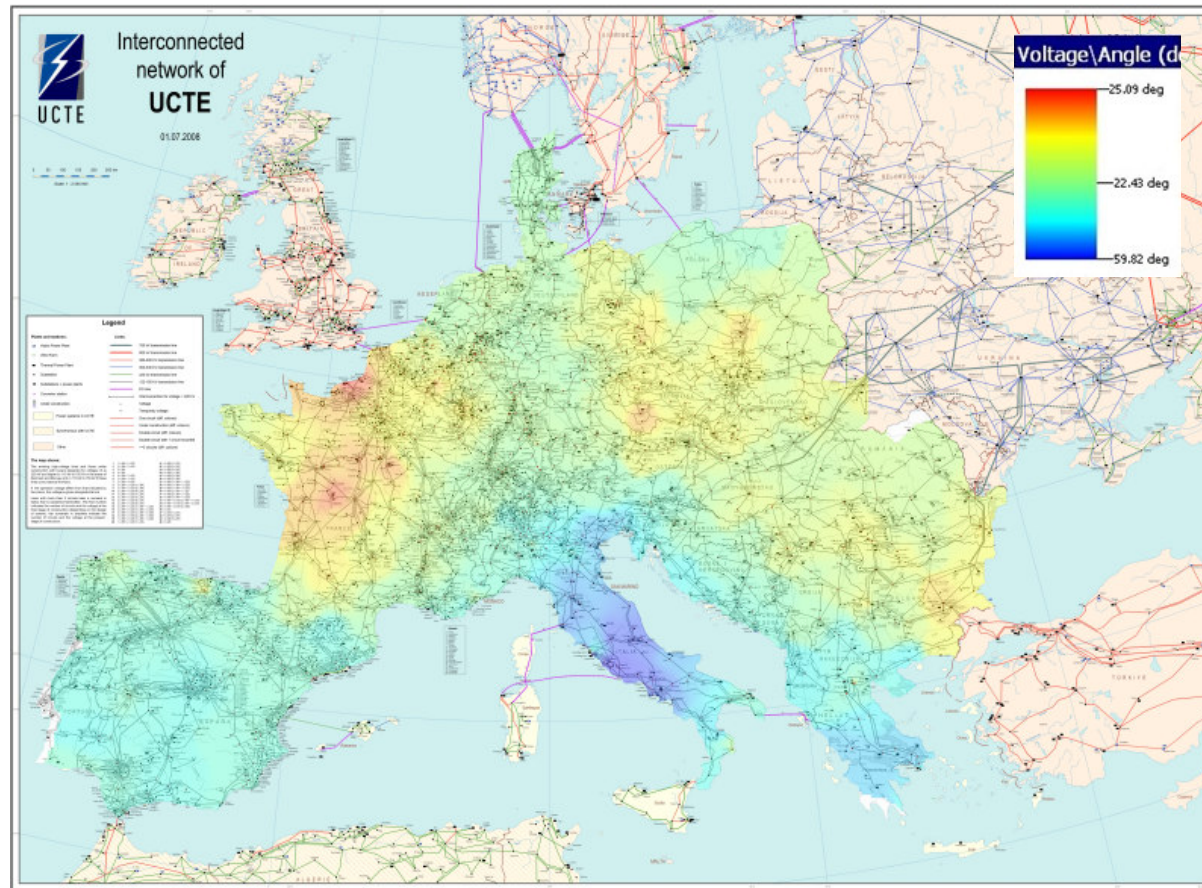
- ~ 10'000 nodes
- ~ 6'000 lines
- ~ 1'000 generators

Application 1: Operational Security



- Voltage angle as a measure for generation, consumption & flow pattern.
- High gradient indicates pot. critical situation.
- Examples of 16 July 2008, 10.30 am (**high wind**) ...

Application 1: Operational Security



- Voltage angle as a measure for generation, consumption & flow pattern.
- High gradient indicates pot. critical situation.
- Examples of 16 July 2008, 10.30 am (wind) ...
- And 03.30 am (**low wind**)

Application 2: Market

- One price for Europe (“copper plate”) is the *wrong* goal.
- The value of generation is dynamic: It varies by location and time.
- Locational/Nodal pricing is required.
- Provides price signals for generation investment & grid expansion.

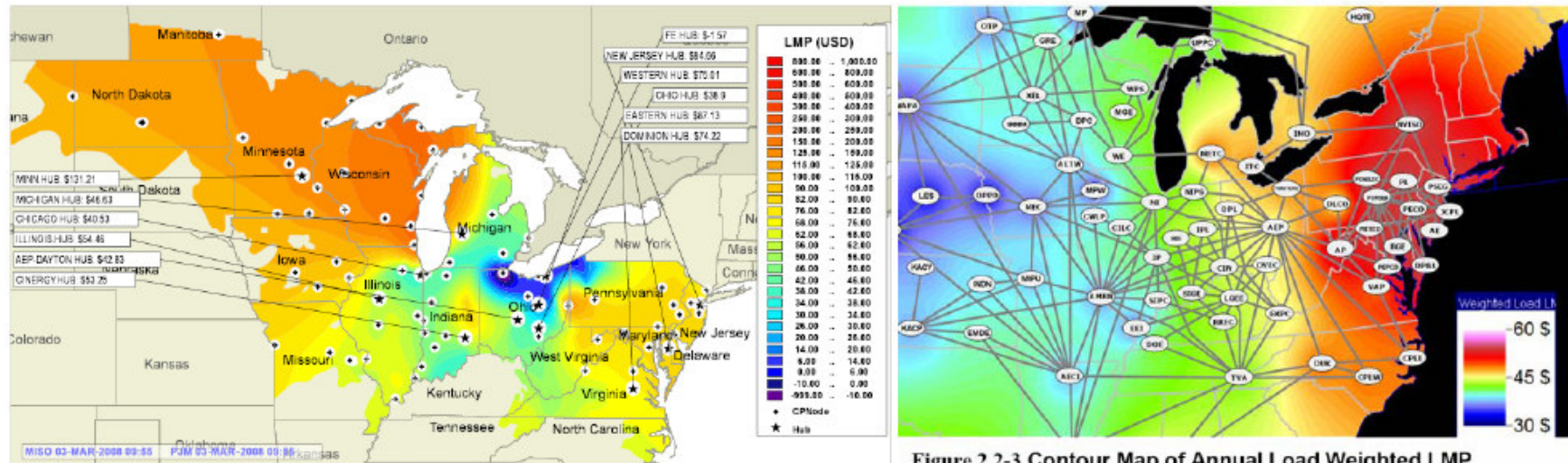


Figure 2.2-3 Contour Map of Annual Load Weighted LMP
Source: MISO/PJM (2008)

Minnesota Hub: \$131.21/MWh. First Energy Hub: \$-1.57/MWh.

Policy Impact

- The current capacity allocation scheme is reaching its limits
 - Lack of coherence between institutions and technology
 - Short term driver: Economic crisis => different generation & consumption pattern.
 - Long term driver: Integration of large amounts of variable Renewables
- Recommendation: Nodal pricing based on the full network model as a *target model* for policy makers and regulators
 - Creating a truly integrated European electricity market
 - Providing accurate price signals for generation investments and network expansion: Crucial to reach sustainability goals
 - Key instrument to increase operational network security.
- Next steps:
 - Create transparent market efficiency indicators
 - Rethinking of institutional setup on European, national, and local level.

Thank You!